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ABSTRACT

Four problems in children's paired-associate memory were addressed: (1) reappraisal of the presumed developmental trend in presentation mode effect during grade-school years, (2) identification of the locus of this developmental effect, (3) evaluation of the influence of combined presentation (verbal plus pictorial) relative to pictorial presentation on the storage and retrieval of pairs, and (4) evaluation of the influence of combined presentation relative to verbal presentation. Five hundred seventy-six children (144 each from kindergarten and grades 2, 4 and 6) memorized 32 pairs of common nouns by the study-test recognition procedure. Results indicated an increasing superiority of pictorial over verbal presentations during the grade-school years. This Grade x Presentation Mode interaction was observed in the storage phase of task performance but not in the retrieval phase. Combined presentation did not influence either the storage or retrieval of pairs relative to pictorial presentation but did enhance the storage of pairs relative to verbal presentation. A developmental trend in combined presentation relative to verbal presentation was observed in the retrieval of pairs such that retrieval was facilitated by combined presentation with older children, while presentation mode did not affect retrieval for younger children. Results are discussed in terms of dual coding and elaboration theories of paired-associate memory. (Author/JB)

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# Developmental Changes in the Effects of Presentation Mode on the Storage and Retrieval of Noun Pairs in Children's Recognition Memory

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## Footnotes

A version of this paper, titled "Storage and Retrieval of Noun Pairs in Children's Recognition Memory as a function of Presentation Mode and Age," was presented at the biennial meeting of the Society for Research in Child Development, San Francisco, California, March 1979.

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## Abstract

The present study addressed four problems in children's paired-associate memory: (1) reappraisal of the presumed developmental trend in presentation mode effect (i.e., the increasing superiority of pictorial over verbal presentations) during the grade-school years, (2) identification of the locus (storage vs. retrieval) of this developmental effect, (3) evaluation of the influence of combined presentation (verbal plus pictorial) relative to pictorial presentation on the storage and retrieval of pairs, and (4) evaluation of the effects of combined presentation relative to verbal presentation on the storage and retrieval of pairs. To these ends, nine experimental conditions were partitioned into three experimental designs. A total of 576 children, drawn in equal numbers from four grade levels (kindergarten vs. second vs. fourth vs. sixth) memorized a 32-pair list of common nouns by the study-test recognition procedure. The results indicated an increasing superiority of pictorial over verbal presentations during the grade-school years. This Grade x Presentation Mode interaction was observed in the storage phase of task performance, but not in the retrieval phase of task performance. Combined presentation did not influence either the storage or retrieval of pairs relative to pictorial presentation. However, combined presentation did enhance the storage of pairs relative to verbal presentation. Furthermore, a developmental trend in combined presentation relative to verbal presentation was observed in the retrieval of pairs such that pair retrieval was facilitated by combined presentation with older children, while presentation mode (combined vs. verbal) did not affect the retrieval of pairs for younger children. The results from this study are discussed in terms of dual coding and elaboration theories of paired-associate memory.

Developmental Changes in the Effects of Presentation Mode on the Storage and Retrieval of Noun Pairs in Children's Recognition Memory

Children's paired-associate learning of noun pairs can be influenced by the factor of presentation mode. A frequent comparison made in recent research has been between the pictorial presentation of noun referents (e.g., object drawings) depicted side-by-side versus the aural-verbal presentation of the noun labels (cf. Pressley, 1977). The typical outcome of this comparison has been that pictorial presentation is associated with a higher level of paired-associate performance than verbal presentation (e.g., Kee, 1976). Research evidence has also suggested that the superiority of pictorial to verbal presentation may increase (i.e., an Age x Presentation Mode interaction) during childhood (cf. Pressley, 1977).

Many of the popular explanations for the presentation mode effect and the associated developmental trend have been based on Paivio's suggestion that both verbal and imagery representational codes can underlie the storage of concrete stimuli (cf. Paivio, 1970; Pressley, 1977; Reese, 1970, 1977; Rohwer, 1970). Both codes are presumed to be used by adults and older children for the efficient storage of to-be-remembered (TBR) concrete stimuli (i.e., dual coding). In young children, however, specific encoding of stimuli within the different representational forms is hypothesized. Presentation mode is a factor presumed to affect specific encoding such that verbal presentation of pairs prompts encoding primarily in the verbal representational form, whereas pictorial presentation prompts encoding primarily in the imagery representational form. Thus, the presentation mode effect observed with young children (e.g., ages five to seven) can be interpreted to reflect the greater hospitality of the imagery code relative to the verbal code for the storage of concrete stimuli (cf. Kee, 1976).

With regard to the developmental trend in presentation mode effect, two different types of explanations have been advanced within the dual coding framework (cf. Rohwer, Kee & Guy, 1975). The first places principal emphasis on the storage phase of task performance. It suggests that children's propensity to encode pictorial pairs in both the verbal and imagery representational forms (i.e., dual coding) increases during childhood. That is, five and seven year old children will encode pictorial pairs primarily in the imagery code, whereas older children (e.g., nine and eleven years) will tend to spontaneously encode pictorial pairs in both the verbal and imagery forms. Furthermore, during the childhood age range children do not display a corresponding increase in their propensity for the dual coding of verbal pairs. That is, throughout childhood verbal pairs are primarily encoded within the verbal representational form. Thus, the developmental trend in presentation mode effect can be attributed to an increase in the availability of pairs in memory as a function of age due to corresponding age related changes in the number of representational codes used to store the pictorial pairs. An alternate type of hypothesis has focused on the retrieval phase of task performance. Many of the studies which have been concerned with the developmental trend in presentation mode effect have indexed task performance by the cued recall method. Based on this observation, it has been suggested that the Age x Presentation Mode interaction may simply reflect differential decoding from the imagery representational form during childhood. That is, both pictorial pairs and verbal pairs are specifically encoded within their respective representational forms (i.e., verbal and imagery) throughout childhood. The imagery code is more hospitable for the storage of pairs than the verbal code. Young children (e.g., about five years of age), however, encounter more difficulty than older children (e.g., nine years) at decoding imagery representations into the appropriate verbal responses at test for successful task performance. Thus, the Age x Presentation Mode interaction in

paired-associate performance.

A review of the extant literature pertinent to the Age x Presentation Mode interaction in paired-associate learning indicates that this interaction during childhood has not been accurately nor reliably characterized. For example, research by Dilley and Paivio (1968) and Calhoun (1974), which have been typically cited in connection with this issue (cf. Pressley, 1977), have limitations which place into question the appropriateness of the presentation mode comparisons made. In the Dilley and Paivio (1968) study, subjects were apparently encouraged to label TBR pairs under pictorial presentation conditions on the initial study trial. Thus, the functional comparison in their study may have been verbal presentation versus pictorial plus subject generated labels. In the study by Calhoun (1974), subjects in the cued recall test condition were also encouraged to label TBR pictorial pairs. In addition, the influence of presentation mode was evaluated within subjects by a mixed-list paired-associate procedure. The mixed-list procedure used by Calhoun (1974) may not have provided an accurate estimate of presentation mode effects. One problem is that list items were not completely counterbalanced across presentation conditions. Furthermore, estimates of presentation mode effects may have been contaminated by problems of item selection (cf. Frederiksen & Rohwer, 1974). Thus, a pure list appraisal of potential developmental changes in presentation mode effect would have been more desirable (cf. Postman, 1978). A study by Rohwer et al (1975) provided a between subjects analysis of pure verbal versus pure pictorial presentations. Their results indicated that the superiority of pictorial to verbal presentations increased across the four to seven year age range. However, this Age x Presentation Mode interaction was not statistically reliable in their study.

One purpose of the present study was to provide a reappraisal of the presumed developmental trend in presentation mode effect in childhood. Thus, a between subjects comparison of pure verbal versus pure pictorial presentations

was made. The complete grade-school age range (i.e., kindergarten to sixth grade) was sampled in the present study in order to provide a more complete characterization of potential developmental changes in presentation mode effects than that offered in previous studies (e.g., Rohwer et al, 1975).

A second major purpose of the present study was to provide evidence concerning the locus (storage vs. retrieval) of the developmental trend in presentation mode effects. This evidence should facilitate a selection between the different hypotheses (e.g., dual coding at storage vs. response decoding at retrieval) which have been advanced to account for the Age x Presentation Mode interaction. In the present study, the division of paired-associate task performance into storage and retrieval phases which could be designated as possible loci of the presentation mode effect was examined by the use of a study-test recognition procedure. This procedure is similar to that used successfully by Kee (1976) to study the effects of elaboration on the storage and retrieval of pairs in children's associative memory. The study trial in the task is identified with the storage phase of task performance and consists of the presentation of each TBR pair for study. The test trial in the task is identified with the retrieval phase of task performance and consists of the presentation of old items intermixed with new items for an old or new recognition response. An important feature of this procedure is that both members of a pair are presented at study and test, thereby allowing for the equivalent and independent manipulation of presentation mode on the study and test trials. A potential inferential problem in storage and retrieval analyses of this type is that estimates of storage can only be made at the time of retrieval (i.e., at test). In the present study, the equivalent and independent manipulation of presentation mode at study and test should serve to minimize this problem.

A final objective of the present study was to evaluate the influence of a combined presentation condition (i.e., verbal plus pictorial) on children's

paired-associate learning. As previously discussed, the encoding of pairs in the different representational forms by young children is posited to be influenced by presentation mode. Thus, it was expected that combined presentation should prompt dual coding of pair members, thereby allowing for optimal task performance. Comparisons between combined presentation versus pictorial presentation and combined presentation versus verbal presentation may, therefore, provide an indication of the degree to which dual coding augments paired-associate task performance relative to verbal or imagery encoding during the grade-school years.

Previous studies with children, using both the mixed-list and pure list evaluation methods, suggest that combined presentation at study improves paired-associate performance relative to verbal presentation (e.g., Frederiksen & Rohwer, 1974) and pictorial presentation (e.g., Kee & Rohwer, 1973). A developmental study by Rohwer, Ammon, Suzuki, & Levin (1971) examined the influence of presentation conditions within subjects (i.e., mixed-list procedure) across the grade levels of kindergarten versus first versus third. Their results indicated that the superiority of combined presentation relative to verbal presentation remained invariant across grade levels, whereas the superiority of combined presentation relative to pictorial presentation appears to decrease with grade level. This developmental pattern of presentation mode effects is consistent with the previously discussed characterization of representational encoding in childhood. That is, children's propensity to dually encode pictorial pairs in both the verbal and imagery codes increases during childhood, whereas a parallel increase in the dual coding of verbal pairs is not evidenced during this age range. It is important to note, however, that the developmental changes in the superiority of combined versus pictorial presentation have not always been observed (e.g., Means & Rohwer, Note 1; Rohwer et al, 1975).

In the present study, the effects of combined presentation on children's paired-associated learning were evaluated over a wider age range than that of-

fered in previous studies (e.g., Means & Rohwer, Note 1; Rohwer et al, 1975). Furthermore, a more comprehensive assessment of potential combined presentation mode effects is provided relative to previous experiments because the influence of combined presentation is evaluated at both the storage (i.e., on the study trial) and retrieval (i.e., on the test trial) phases of paired-associate task performance.

In summary, the present study addressed four specific problems: (a) the reappraisal of the presumed developmental trend in presentation mode effect (verbal vs. pictorial) in the grade-school age range, (b) an identification of the locus of this developmental trend in presentation mode effect (i.e., storage vs. retrieval), (c) evaluation of combined presentation mode effects on the storage and retrieval of pairs relative to pictorial presentation, and (d) evaluation of combined presentation mode effects on the storage and retrieval of pairs relative to verbal presentation.

## Method

### Subjects

A total of 576 children, drawn in equal numbers from four grade levels served as subjects. The mean ages, standard deviations and age ranges for the four groups were: Kindergarten--5.76 years, 3.64 months, 5.16 to 6.75 years; second grade--7.77 years, 4.64 months, 6.41 to 9.16 years; fourth grade--9.73 years, 4.19 months, 8.17 to 10.50 years; sixth grade--11.98 years, 5.21 months, 9.50 to 12.91 years. All of the children attended school and resided in a upper socioeconomic status white community in Los Angeles, California. Equal numbers of boys and girls from each grade level were randomly assigned to the experimental conditions.

### Design

In the present experiment nine experimental conditions were arranged into three experimental designs so that some conditions appeared in only one design,

while others appeared in two. In addition to the manipulated factors in each design, all three designs were balanced with regards to three other factors: grade level (kindergarten vs. second grade vs. fourth grade vs. sixth grade), subject's sex and experimenter. Although the designs are presented successively, the order of testing subjects was conducted in a manner that permitted each condition to be represented during every phase of data collection.

The first design provides an evaluation of the loci of the developmental trend in presentation mode (verbal vs. pictorial) effect. Thus, the principal factors in the design consisted of grade level, study condition (verbal vs. pictorial) and test condition (verbal vs. pictorial). In this design, assessment of the storage locus of the developmental trend in presentation mode effect is provided by the test of the Grade Level x Study Condition interaction, while assessment of the retrieval locus of the developmental trend in the presentation mode effect is provided by an evaluation of the Grade Level x Test Condition interaction.

The second and third experimental designs are concerned with evaluating the influence of combined presentation on the storage and retrieval of pairs. The principal factors in design 2 consisted of grade level, study condition (pictorial vs. combined) and test condition (pictorial vs. combined). The principal factors in design 3 consisted of grade level, study condition (verbal vs. combined) and test condition (verbal vs. combined). These designs will provide evidence concerning the effectiveness of combined presentation relative to the independent presentation of either verbal or pictorial pairs in paired-associate performance. Furthermore, grade-level related changes in the relative superiority of combined presentation to pictorial presentation and/or verbal presentation will bear on the issue of developmental changes in the propensity of children for dual coding. For example, the finding of a decreasing superiority of combined presentation relative to pictorial presentation

in design 2 as a function of grade level (i.e., a Grade Level x Study Condition interaction) would be consistent with the hypothesis that the propensity of children to dually encode pictorial pairs increases during childhood.

Materials

A 32-pair list of common nouns (e.g., shoe-chair, ship-buggy, etc.) was assembled. The pictorial pairs consisted of black on white line drawings of noun referents depicted side-by-side. Transparencies of the drawings were made and presented to subjects by 35mm slide projector. Pretesting was conducted in order to determine the most common labels used by children for the pictorial pairs. These labels were used for the verbal presentation of pairs and were recorded with a female voice on cassette tape. Verbal pair presentation was made by Wollensak Cassette Recorder (Model 2551). For the combined presentation condition, the presentation of verbal pairs on the cassette recorder plus the pictorial pairs on the slide projector was synchronized.

Two random orders of the 32-pair list were created, one for use on the study trial and the other for use on the test trial. A test list was created from the orignial 32-pair list and consisted of 16 old pairs (i.e., pairs identical to that used on the study list) inter-mixed with 16 repaired items. Two test lists were used in order to counterbalance old and new (i.e., repaired) items, that is, old pairs in one list would be the new pairs in the other list and vice versa. The presentation order of pairs on the test trial was constrained so that no more than three old or new pairs would be presented in succession. It is important to note that because new pairs consisted of repaired old items, observed performance differences in the present study are free from the influence of item familiarity and can be attributed solely to differences in associative knowledge.

Procedures

Subjects were examined individually by one of two female experimenters in testing rooms provided at the participating elementary schools. A study-test paired-associate procedure was used. Subjects were seated at a small table. A side-screen projection unit was located on the table a short distance in front of the subject. Subjects were informed that a 32-pair list of common objects would be presented and that they should study each pair presented so that they could remember which two things went together on the list. Four example pairs were presented to illustrate the task. These pairs were presented in the same mode to be used on the study trial. Subjects were told that their memory would be tested, but no information was provided about the potential variation in presentation mode on the test trial. The rate of pair presentation on the study trial was 4 seconds per pair with a .5 second inter-pair interval.

Approximately 120 seconds intervened between the study and test trials. Subjects were told during this interval that 32 additional pairs would be presented. The subjects were informed that half of the pairs were identical to study trial pairs, while half would be repaired. The subjects were tested by the yes/no recognition method. That is, subjects verbally responded "yes" if the pair was identical to a study trial pair and verbally responded "no" if the pair represented the repairing of items from the study trial. If presentation mode changed between study and test, the subject was requested to make all yes/no recognition decisions based solely on pair membership. A subject paced presentation rate was used on the test trial in which a test pair was not advanced until the subject provided a response. A record was kept of the amount of time required by each subject to complete the test cycle.

Results and Discussion

Two indices of recognition performance were evaluated for the three

experimental designs: (a) a corrected recognition score, the difference between hits (subjects responds old to an old pair) and false alarms (subject responds old to a new pair) and (b) the d' index of signal detection theory (cf. Banks, 1970). An examination of the means for the experimental conditions and the outcome of the analyses performed indicated that identical patterns of recognition performance were reflected by the two measures. The Pearson coefficient of correlation between the two measures was +.98. Because the corrected recognition score provides a more meaningful measure of recognition performance than d' for comparison with previous studies concerned with presentation mode effects in children's associative memory, only the analyses conducted on the corrected recognition scores will be presented.

The Type I error rate for all tests was set at .05. The analyses performed indicated that the factors of subject's sex and experimenter did not serve to alter conclusions drawn about the primary factors in each design (i.e., grade level, study condition, and test condition). Thus, the factors of subject's sex and experimenter will not be treated in the results presented. In each of the designs, grade level effects were evaluated by trend components.

Design 1: Verbal versus Pictorial

The first design provides an assessment of the developmental trend in presentation mode effect. Table 1 presents the mean corrected recognition

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Insert table 1 about here

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scores as a function of grade level, study condition and test condition. The analysis of variance revealed a significant main effect for grade level (linear component only), $F$ (1, 192) = 40.70, indicating that recognition performance increased systematically with grade level (Ms: kindergarten = 2.84, second grade = 3.86, fourth grade = 5.00, and sixth grade = 6.36).

A study condition effect was observed, $F$ (1, 192) = 24.23, and indicated that pictorial presentation ($M$ = 5.52) was associated with a higher level of recognition performance than verbal presentation ($M$ = 3.51). The test condition effect was not significant, $F$ (1, 192) = 1.99. However, a significant Study Condition x Test Condition interaction was observed, $F$ (1, 192) = 9.97. Simple effects analysis conducted within each level of study condition revealed that test condition (verbal test $M$ = 3.89, pictorial test $M$ = 3.16) did not affect recognition performance for verbal study conditions, $F$ (1, 192) = 1.44, whereas in the pictorial study condition recognition performance was impaired by verbal test pairs ($M$ = 4.59) relative to pictorial test pairs ($M$ = 6.45) $F$ (1, 192) = 10.17. This outcome, consistent with a finding previously reported by Kee (1976) for second and third grade subjects, indicates that while pictorial presentation at study serves to enhance the storage of pairs relative to verbal presentation, efficient accessibility to pairs under pictorial study conditions require the use of pictorial test pairs. This finding may reflect differential accuracy in test-pair recoding by grade-school age subjects. That is, when a subject is presented with test pairs in a mode incongruent with study, the subject recodes the test pair into the medium of study in order to make a recognition decision. Because a greater variety of images can be produced to characterize a word than the number of nouns which can be generated in response to a given picture, subjects were more likly to recode pictorial test pairs into the same verbal descriptions as presented at study than verbal test pairs into the identical images presented at study.

With regard to the issue of a developmental trend in presentation mode effect, the analysis of variance indicated a significant Grade Level (linear component only) x Study Condition interaction, $F$ (1, 192) = 5.94. The Grade Level (all components) x Study Condition and Grade Level (all components) x

Study Condition x Test Condition interactions were not significant (all F ratios were less than 1). The form of the significant Grade Level x Study Condition interaction indicated that the superiority of pictorial to verbal presentations increased systematically with age (the difference in mean corrected recognition scores, pictorial minus verbal, at each grade level was: kindergarten = .57, second grade = 1.72, fourth grade = 2.49, and sixth grade = 3.28). Simple effects analysis conducted within each grade level indicated reliable study condition effects at all grades except kindergarten.

The finding of a significant Grade Level x Study Condition interaction serves to replicate the target phenomenon of interest. This outcome, in conjunction with the absence of grade-level changes in test condition effects (i.e., Grade Level x Test Condition and Grade Level x Study Condition x Test Condition interactions) implies that the locus of the developmental trend in presentation mode effect (verbal vs. pictorial) is in the initial storage of pair members as opposed to their retrieval.

Design 2: Pictorial versus Combined

The isolation of the developmental trend in presentation mode effect in the initial storage of pairs is consistent with the dual coding hypothesis. It will be recalled that this hypothesis suggested that young children encode pairs into the representational form which is most directly associated with the sensory mode of presentation (i.e., verbal pairs are encoded verbally, whereas pictorial pairs are encoded imaginally). Older children, however, are hypothesized to encode pictorial pairs in both the verbal and imagery representational forms, thereby allowing for optimal task performance. The manipulations included in the second experimental design provide for a direct assessment of this developmental dual coding hypothesis. Specifically, the dual coding interpretation suggests that combined presentation of pairs

should enhance paired-associate task performance relative to pictorial presentation due to the prompting of dual coding. This difference in paired-associate task performance (i.e., combined vs. pictorial) should decrease with grade level because of corresponding increases in the spontaneous dual coding of pictorial pairs by the older children (i.e., grades four and six).

Table 2 presents the mean corrected recognition scores for the second design as a function of grade level, study condition, and test condition. Signif-

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icant grade level effects were observed: Linear component--$F$ (1, 192) = 56.06 and Quadratic component--$F$ (1, 192) = 5.02. Generally speaking, recognition performance increased with grade level (Ms: kindergarten = 4.77, second grade = 5.36, fourth grade = 6.70 and sixth grade = 9.30).

The study condition effect was not significant, $F < 1$, nor was the critical Grade Level (all components) x Study Condition interaction, $Fs < 1$. These findings are contrary to prediction from the dual coding hypothesis of the developmental trend in presentation mode effect which suggested that a decreasing advantage of combined presentation over pictorial presentation would be observed.

The test condition main effect, $F < 1$, and the Grade Level (all components) x Test Condition interactions were not significant (largest $F$ ratio was for the Linear Grade Level x Test Condition interaction = 3.36, $p > .05$). A significant Grade Level (linear component) x Study Condition x Test Condition interaction, however, was detected, $F$ (1, 192) = 5.01. The form of the interaction suggested that within the pictorial study condition, both pictorial and combined test pairs offered equivalent accessibility to pair members in memory at the different grade levels, whereas in the combined study conditions, test pairs differentially affected accessibility as a function

of grade level. That is, at the kindergarten grade level, combined test pairs impaired recognition performance relative to pictorial test pairs, whereas at the older grade levels (e.g., sixth grade) combined test pairs improved accessibility to pairs relative to pictorial test pairs. A test of simple effects, however, failed to reveal any significant differences between test conditions within any of the Grade Level x Study Condition combinations (largest $F$ ratio = 3.74).

Although the first experimental design isolated the developmental trend in presentation mode effect in the initial storage of pairs, the absence of a Grade Level x Study Condition interaction in the second experimental design places in doubt the dual coding explanation for the increasing superiority of pictorial to verbal presentation in paired-associate performance. An additional test of this dual coding hypothesis is afforded in the second design by evaluating the effects of test condition (pictorial vs. combined) within the pictorial study condition. That is, if older children spontaneously encode pictorial pairs in both the verbal and imagery forms at study, the combined test condition should more closely match the conditions of item storage, thereby facilitating accessibility to items in memory (cf. Tulving & Thomson, 1971) at the older grade levels. Inspection of the relevant means in Table 2, however, reveal equivalent accessibility for the two test conditions to items encoded under pictorial study.

The parity in performance observed in the second design between combined and pictorial presentations may suggest that subjects throughout the grade-school age range may have been spontaneously encoding pictorial pairs in both the verbal and imagery representational forms, hence, no additional benefit would be expected for combined presentation. This interpretation would be consistent with reports that young children demonstrate some propensity for labeling pictorial stimuli (cf. Pressley, 1977). However, there is

uncertainty concerning whether or not this spontaneous labeling of pictures is associated with verbal memory consequences in paired-associate learning, particularly for younger children (ages five to seven). For example, Cramer (1975, 1976) has reported that the spontaneous verbal encoding of information for pictorial paired-associates does not emerge until the fourth grade. Evidence of this type is incompatible with the notion that young children spontaneously engage in the dual encoding of pictorial pairs in paired-associate memory.

It will be recalled that some previous studies have reported a developmental trend in combined presentation mode effects at study such that the superiority of combined presentation relative to pictorial presentation decreased with age during the early grade-school years. Design differences, in part, may serve to account for the discrepancies in results concerning developmental changes in combined presentation mode effects. For example, the developmental trend in combined presentation mode effects has been most consistently detected in studies which have evaluated presentation condition effects by the mixed-list procedure (e.g., Rohwer et al, 1971), whereas this developmental trend has not been consistently detected in studies which have used a between subjects evaluation (e.g., Means & Rohwer, Note 1; Rohwer et al, 1975). As previously discussed, mixed-list evaluations of presentation condition effects can be contaminated (e.g., by problems of item selection). Thus, estimates of presentation condition effects are more robust when between subject comparisons of presentation mode are made. The results from the present between subjects evaluation of presentation mode effects are clear: Combined presentation does not affect paired-associate performance relative to pictorial presentation at either study or test across the complete grade-school age range.

Design 3: Verbal versus Combined

The last design provides an opportunity to evaluate whether combined presentation influences recognition performance relative to verbal presentation.

Within a dual coding framework, the results from this design will provide estimates of the degree to which children spontaneously encode verbal pairs in both representational forms (i.e., verbal and imagery) during the grade school years. Table 3 presents the mean corrected recognition scores

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Insert Table 3 about here

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for the third design as a function of grade level, study condition and test condition. Significant grade level effects were observed: Linear component--$F$ (1, 192) = 41.21 and quadratic component--$F$ (1, 192) = 8.89. Scheffé comparisons indicated that recognition performance of the sixth grade subjects ($M$ = 7.20) was superior to that of the fourth grade subjects ($M$ = 4.30), which in turn was superior to performance at the second ($M$ = 3.38) and kindergarten ($M$ = 3.17) grades, which did not differ from one another.

A study condition effect was observed, $F$ (1, 192) = 31.36, and indicated that combined presentation ($M$ = 5.78) was associated with a higher level of paired-associate recognition than verbal presentation ($M$ = 3.24). The Grade Level (all components) x Study Condition interactions were not significant (all $F$ ratios were less than 1), indicating that the advantage of combined presentation over verbal presentation was invariant across the grade-school age range. An implication of this finding within the dual coding framework is that children in this age range do not differ in their propensity to spontaneously dual encode verbal pairs.

The test condition effect was also not significant, $F < 1$, however a significant Study Condition x Test Condition interaction was observed, $F$ (1, 192) = 13.22. A test of simple effects conducted within each level of study indicated that test condition did not affect recognition within the verbal study condition (verbal test $M$ = 3.86, combined test $M$ = 2.63), $F$ (1, 192) = 3.86, whereas in the combined study condition recognition performance was impaired with verbal

test pairs ($M$ = 4.75) relative to combined test pairs ($M$ = 6.81), $F$ (1, 192) = 8.71.

Finally, a Grade Level (linear component) x Test Condition interaction was observed, $F$ (1, 192) = 8.71. Simple effects analysis conducted at each grade level revealed that the verbal and combined test conditions offered equivalent accessibility to items in storage except at the sixth grade level. At this grade level, recognition performance was superior with combined test pairs relative to verbal test pairs.

In summary, the results of the last design indicate that combined presentation at study facilitates paired-associate recognition relative to verbal presentation at study over the grade-school age range. Although this facilitation at study is invariant across the grade levels sampled, developmental changes in the accessibility to items may be observed such that at older grade levels (i.e., sixth grade) combined test pairs offer more efficient accessibility to items in memory than verbal test pairs.

Test Time

It will be recalled that a subject-paced test trial was used. The amount of time required by subjects to complete their test trials was recorded and analyzed. The analysis revealed only eight significant effects in the three different designs. In each design significant grade level effects (linear components only) were observed: Design 1--$F$ (1, 192) = 27.13; Design 2--$F$ (1, 192) = 43.61 and Design 3--$F$ (1, 192) = 71.14. Generally speaking, these effects indicated that the amount of time required by subjects to complete the test trial decreased with grade level. For example, in design 1 the mean test time in seconds for the different grade levels was: kindergarten = 244.00, second grade = 233.50, fourth grade = 231.40, and sixth grade = 203.90.

In the first design (verbal vs. pictorial) a significant Grade Level (linear component) x Test Condition interaction was observed, $F$ (1, 192) =

10.10. The form of the interaction indicated that the decrease in test time with grade level was more severe under verbal test conditions than pictorial test conditions. A significant Study Condition x Test Condition interaction, $F$ (1, 192) = 19.68, was also detected in the first design. Test of simple effects indicated that congruent study-test conditions were associated with a reduction in test time relative to incongruent study-test conditions (verbal study-verbal test $M$ = 217.10 sec, verbal study-pictorial test $M$ = 247.70 sec, pictorial study-verbal test $M$ = 232.00 sec, and pictorial study-pictorial test $M$ = 216.00 sec). In the second (pictorial vs. combined) and third (verbal vs. combined) designs significant test condition effects were observed, $F$ (1, 192) = 14.04 and $F$ (1, 192) = 9.92, respectively. These test condition effects reflect a reduction in test time associated with combined test pairs relative to pictorial test pairs in design 2 (combined minus pictorial difference = 17.80 sec) and combined test pairs relative to verbal test pairs in design 3 (combined minus verbal difference = 14.50 sec). Finally, a significant Study Condition x Test Condition interaction was detected in the third design (verbal vs. combined), $F$ (1, 192) = 8.96. Test of simple effects within each level of study indicated that test condition did not affect test time in the verbal study condition (verbal test $M$ = 217.50 sec vs. combined test $M$ = 216.00 sec), whereas in the combined study condition combined test pairs ($M$ = 198.90) were associated with a significant reduction in test time relative to verbal test pairs ($M$ = 227.60 sec).

## General Discussion

Previous studies of children's paired-associate learning have suggested that the superiority of pictorial to verbal presentations may increase during the grade-school years. Hypotheses advanced to account for this developmental trend in paired-associate performance have focused on either developmental changes in the character of item storage (e.g., a developmental increase in the dual coding of pictorial pairs) or in developmental improvements in the accuracy of item retrieval from the imagery representational code. The results from

the first experimental design indicate a Grade Level x Presentation Mode (verbal vs. pictorial) interaction at the time of pair encoding, but not at the time of pair retrieval. This finding is consistent with the hypothesis which emphasized developmental differences in the character of pair storage and is clearly incompatible with the hypothesis which placed principal emphasis on developmental differences in pair retrieval.

The manipulations included in the second design of this study provided an opportunity to evaluate the hypothesis that the developmental change in the storage of pictorial pairs could be attributed to developmental differences in subjects' propensity for the dual encoding of such pairs in both the verbal and imagery representational forms. The results from the second design, however, failed to provide evidence to support this hypothesis. For example, a decreasing superiority of combined presentation relative to pictorial presentation was not observed. Thus, while the results of the first design serve to isolate the developmental trend in presentation mode effect in the initial storage phase of paired-associate task performance, the findings from the second design places in doubt the dual coding explanation for this developmental storage effect.

To this point, Paivio's dual coding framework in memory has provided the basis for explanatory hypotheses concerning the developmental trend in presentation mode effect. An alternate framework for evaluating this developmental trend is provided by Rohwer's Elaboration Hypothesis (cf. Rohwer, 1973). Rohwer (1973) has suggested that when relationships are formed between pair members in memory, a single elaborative code is responsible. According to Rohwer, elaboration consists of the creation of a semantic episode which meaningfully relates the TBR pair members, thereby increasing their availability in memory. This view of efficient paired-associate retention suggests that the developmental trend in presentation mode may reflect the more robust nature of pictorial presentation relative to verbal for prompting elaborative coding in

children's memory. For example, pictorial presentation may suggest a greater variety of potential elaborations for TBR pair members to subjects than verbal presentation. Alternately, pictorial presentation may provide the subject with more time to elaborate pair members because of the simultaneous presentation of referents as opposed to the sequential presentation of noun labels under verbal presentation. Research concerning spontaneous elaboration in paired-associate learning indicates that consistent and efficient spontaneous elaboration under standard memory instruction and standard pair presentation does not emerge until late adolescence (cf. Rohwer & Bean, 1973). However, Pressley and Levin (1977) have reported that during childhood subjects report elaborating some of the items on a paired-associate list. This finding by Pressley and Levin (1977) corresponds with our own observations and informal post experimental questioning of subjects. That is, on the paired-associate list used in the present study, subjects gave evidence of some spontaneous elaboration of pairs, particularly at the older grade levels under pictorial presentation. It will be useful for future research to systematically evaluate the frequency of spontaneous elaboration during the grade-school years as a function of presentation mode. It is important to note that evidence from studies concerning the influence of elaboration instructions on paired-associate learning provide support for the hypothesis that the developmental trend in presentation mode effect (i.e., verbal vs. pictorial) may reflect differences in the spontaneous elaboration of some of the TBR pairs as a function of presentation mode. For example, these studies suggest that when subjects are instructed to elaborate pair members on the study trial, more successful elaboration--inferred from subsequent levels of paired-associate performance--is observed for young children with pictorial presentation than verbal presentation (e.g., Eoff & Rohwer, Note 2; Pressley & Levin, 1978).

In summary, the results from the first experimental design clearly

demonstrated that the developmental trend in presentation mode effect was isolated in the initial storage phase of paired-associate task performance. The second experimental design provided an opportunity to evaluate the dual coding hypothesis of this developmental storage effect. The evidence from this design placed in doubt the notion that the increasing superiority of pictorial to verbal presentations observed in the first design could be attributed to a developmental increase in the propensity of children to spontaneously encode pictorial items in both the verbal and imagery representational forms. Finally, an alternate interpretation of this developmental trend in presentation mode effect was offered drawing on the notion of elaborative encoding in paired-associate learning.

## Reference Notes

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Table 1

Design 1: Mean Corrected Recognition Score as a Function of Study Condition (Verbal vs. Pictorial), Test Condition (Verbal vs. Pictorial), and Grade Level

| Grade Level | | Study Condition | |
|---|---|---|---|
| | | Verbal | Pictorial |
| | Test Condition | | |
| Kindergarten | Verbal | 3.19 | 2.31 |
| | Pictorial | 1.94 | 3.94 |
| Second | Verbal | 2.88 | 3.63 |
| | Pictorial | 3.13 | 5.81 |
| Fourth | Verbal | 4.44 | 5.19 |
| | Pictorial | 3.06 | 7.31 |
| Sixth | Verbal | 4.94 | 7.25 |
| | Pictorial | 4.50 | 8.75 |

Note: $MS_e$ (192) = 10.73

Total possible = 32

Table 2

Design 2: Mean Corrected Recognition Score as a Function of Study Condition (Pictorial vs. Combined), Test Condition (Pictorial vs. Combined), and Grade Level

| Grade Level | Test Condition | Study Condition: Pictorial | Study Condition: Combined |
|---|---|---|---|
| Kindergarten | Pictorial | 3.94 | 6.06 |
| | Combined | 5.19 | 3.88 |
| Second | Pictorial | 5.81 | 5.25 |
| | Combined | 5.25 | 5.13 |
| Fourth | Pictorial | 7.31 | 5.31 |
| | Combined | 6.63 | 7.56 |
| Sixth | Pictorial | 8.75 | 8.25 |
| | Combined | 9.50 | 10.69 |

Note: $MS_e$ (192) = 12.75

Total possible = 32

Table 3

Design 3: Mean Corrected Recognition Score as a Function of Study Condition (Verbal vs. Combined), Test Condition (Verbal vs. Combined), and Grade Level

| Grade Level | | Study Condition | |
|---|---|---|---|
| | Test Condition | Verbal | Combined |
| Kindergarten | Verbal | 3.19 | 4.50 |
| | Combined | 1.13 | 3.88 |
| Second | Verbal | 2.88 | 3.50 |
| | Combined | 2.00 | 5.13 |
| Fourth | Verbal | 4.44 | 4.38 |
| | Combined | .81 | 7.57 |
| Sixth | Verbal | 4.94 | 6.63 |
| | Combined | 6.56 | 10.69 |

Note: $MS_e$ (192) = 13.16

Total possible = 32